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FINAL REPORT

ON  
OPERATIONAL SUITABILITY TEST  
OF THE  
AIR BASE COMMUNICATIONS SYSTEM

PROJECT NO. APG/CSE/252-AB

1 Aug 55

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Project APG/CSE/2  
AN/VRC-14  
AN/FRC-27  
AN/TRC-28  
AN/PRC-21  
AN/FRR-36  
Communication systems, air base

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HEADQUARTERS  
AIR PROVING GROUND COMMAND  
Eglin Air Force Base, Florida

1 August 1955

PROJECT NO. APG/CSE/252-AB

OPERATIONAL SUITABILITY TEST  
OF THE  
AIR BASE COMMUNICATIONS SYSTEM

1. This is the Final Report on Project No. APG/CSE/252-AB, Operational Suitability Test of the Air Base Communications System. The object of the test was to determine the operational suitability of an Air Base Communications System using the AN/VRC-19 (vehicular transmitter-receiver), AN/FRC-27 (fixed transmitter-receiver), AN/TRC-28 (transmitter with power amplifier and receiver), AN/FRR-36 (fixed station receiver), and AN/PRC-21 (walkie-talkie) VHF/FM radio sets.

2. Factors considered in this test were:

a. Effective and efficient communications for dispatch and control of vehicles of air base organizations.

b. Capabilities and limitations of the equipments when operated in an Air Base Communications System.

c. Organizational impact of the equipments as it affects installation, operation, training, maintenance and logistical support.

3. The equipments meet their respective communications requirements, are operationally suitable, and can be successfully integrated into an Air Base Communications System. However, use of the equipment for dispatch and control of motor pool vehicles is not always economical. The cost of this communications equipment is approximately the same as the cost of a light vehicle. Therefore, to achieve maximum utility of radio communication, they must be used on vehicles that are closely controlled and used on frequent trips of short duration. The AN/VRC-19 for non-tactical USAF vehicular use is physically larger and heavier than normally required, limiting luggage or other usable space. As a result of these deficiencies, APGC Interim Report on this project recommended that commercial equipment be considered. Headquarters, USAF has since advised that commercial equipment will not be procured in lieu of the AN/VRC-19 since it will not provide

continuity of engineering design and similar maintenance characteristics. Commercial equipment may be leased under the provisions of AFR 102-16A and utilized in the non-tactical communications system.

4. The frequencies authorized by AFR 102-16 do not permit full system utilization of the two-channel transmitting capabilities which the AN/VRC-19, AN/FRC-27 and AN/TRC-28 possess. The frequencies authorized for commercial facilities, on the other hand, have been arranged in compatible blocks to permit full use of this capability.



ROBERT W. BURNS  
Major General, USAF  
Commander

HEADQUARTERS  
AIR FORCE OPERATIONAL TEST CENTER  
AIR PROVING GROUND COMMAND  
Eglin Air Force Base, Florida

FINAL REPORT

ON

OPERATIONAL SUITABILITY TEST OF  
AIR BASE COMMUNICATIONS SYSTEM

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PROJECT NO. APG/CSE/252-AB

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## **SUMMARY**

### **1. Introduction:**

a. Authority: In a letter to Air Proving Ground Command, dated 27 April 1952, subject: "Proposed Military Characteristics for an Air Base Radio Communications System," Headquarters USAF stated that a decision had been made to standardize certain equipments for non-tactical use and it was proposed that APGC conduct an operational suitability test. In accordance with this proposal and the authority of AFR 80-14, this test was established.

b. Background: The USAF has been using several different types of equipment for non-tactical air base communications systems. Standardization is desirable from the aspects of economic procurement and logistical support, efficient operation and utilization, and the related requirements of personnel training and maintenance.

#### **c. Related Reports:**

- (1) A Flash Report on the Operational Suitability Test of Air Base Communications System, Project No. APG/CSE/252-AB, was transmitted by APGC to AFDRQ, Headquarters USAF, on 23 September 1953.
- (2) Military Specification MIL-N-11539 (SIGC), dated 15 November 1951, and Amendment No. 2, dated 18 March 1952.
- (3) Interim Report on the Operational Suitability Test of Air Base Communications System, Project No. APG/CSE/252-AB, dated March 1955.
- (4) Non-Tactical Radio Equipment System Study, Final Engineering Report, dated 15 February 1955, by the National Defense Division of Motorola, Inc.

### **2. Purpose and Description:**

a. The Air Base Communications System, as proposed, is to satisfy the need for a standard communications system for efficient and economical communications from a mobile or fixed station of an air base organization to a mobile station of the same organization. Further, the system is designed to provide a means, during an emergency, whereby the functions of several organizations of an air base may be efficiently controlled and coordinated by one central command agency.

b. The equipments utilized within the system are crystal-controlled, frequency-modulated units operating in the 152- to 174-megacycle band. They were developed under Signal Corps cognizance

for non-tactical joint service use, and consist of Radio Sets AN/VRC-19, AN/FRC-27, AN/TRC-28, AN/PRC-21, and Radio Receiving Set AN/FRR-36.

3. Object: The object of this test was to determine:

a. Operational suitability of an air base communications system using the AN/VRC-19, AN/FRC-27, AN/TRC-28, AN/FRR-36 and AN/PRC-21 VHF/FM radio sets to effectively and efficiently dispatch and control vehicles of air base organizations.

b. Operational suitability of the AN/VRC-19, AN/FRC-27, AN/TRC-28, AN/PRC-21, and AN/FRR-36 radio sets. The following characteristics were investigated during the test:

- (1) Capabilities and limitations of the equipments when operated in an air base communications system.
- (2) Performance of the equipments as to range, intelligibility, reliability, and interference.
- (3) Organizational impact of the equipments as it affects installation, operation, training, maintenance, and logistical support.

4. Conclusions: It is concluded that:

a. Radio Sets AN/VRC-19, AN/FRC-27, and AN/TRC-28 are operationally suitable for USAF use as an air base communications system over "line-of-sight" ranges when the radio path is unobstructed, in temperatures between  $+165^{\circ}\text{F}$  and  $-65^{\circ}\text{F}$ , and under conditions of high relative humidity.

b. Radio Set AN/PRC-21 (XC-2) is operationally suitable for USAF use as part of an air base communications system over ranges of approximately one mile, in temperatures between  $+165^{\circ}\text{F}$  and  $-20^{\circ}\text{F}$ , and under conditions of high relative humidity.

c. Radio Receiving Set AN/FRR-36 is operationally suitable for USAF use on a single preselected channel.

d. This equipment generally meets the requirements stated in Military Characteristics Number 329, dated 17 February 1953, except as indicated in Appendix VIII, the primary deficiencies being that these sets are larger and heavier than those normally required in USAF non-tactical, commercial-type vehicles.

e. Radio control of several radio nets on an air base from a radio-equipped command post is possible by the installation of monitor receivers at the several base stations.



f. Frequencies authorized by AFR 102-16 do not permit utilization of the two-channel transmitting capability of this equipment, thus limiting the design of an efficient integrated radio system.

g. Efficient operation of the nets is hampered by the lack of modern features such as selective calling, recall and "leave a message" devices.

h. Integration of this equipment into an Air Force Motor Pool, having a specialized utilization rate as explained in Appendix II, paragraph 3b, is not economical.

5. Recommendations: It is recommended that:

a. Air Force Regulation 102-16 be revised to permit the assignment of blocks of frequencies to a particular service instead of the interspersed frequencies presently assigned.

b. Multichannel equipment be developed or procured which will permit more effective and economical control of several air base nets by a central agency.

c. An investigation be made of the feasibility of utilizing lighter, smaller, and less expensive equipments which, when installed, utilize little or no cargo space. (Reference paragraph 2d and e, Appendix II.)

d. An appropriate type hand-held microphone be used in place of the H-33/PT hand set (which includes an earphone) presently supplied. (Reference paragraph 3a(2)(j), Appendix II.)

e. Motorola Model N-140 Portable Test Set be supplied to service units of this system. (Reference paragraph 2j, Appendix II.)

f. A smaller control unit be made available for use in commercial-type vehicles in place of Radio Set Control C-847/U. (Reference paragraph 2d, Appendix II.)

g. Radio Set Control C-845/U be supplied as a separate item so that additional control units may be available when it is desired to operate from more than one location per base station. (Reference paragraph 4i, Discussion.)

h. At least three Special Purpose Electrical Cable Assemblies CX-2371/U be supplied each maintenance activity maintaining Radio Sets AN/VRC-19 and AN/FRC-27. (Reference paragraph 2j, Appendix II.)

i. Manufacturers' Instruction Manuals be issued with all sets as Technical Orders. (Reference paragraph 1b(2), Discussion.)

j. Communications systems of this type be engineered, packaged, supplied, and installed by the appropriate Air Force engineering agencies.

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## DISCUSSION

### 1. Organizational Impact:

a. Personnel: No requirements for additional personnel are incurred by the using organization upon incorporating these equipments into an air base communications system in place of those already in use. Procurement of maintenance personnel for these items, if a system is not in existence, should be calculated on a basis of one Senior Ground Radio Repairman (AFSC 30450) for every 15 sets. Procurement of operating personnel poses no problem, since vehicle operators and dispatchers may be trained to fulfill this requirement.

### b. Training:

- (1) No special training is required for competent repairmen (AFSC 30450).
- (2) Complete manufacturers' maintenance instructions are provided with each set. These were found adequate during the conduct of this test. No Technical Orders have been prepared to date.
- (3) Operating personnel will require indoctrination in communications and operating procedures.

### c. Test Equipment:

- (1) The test equipment listed below, required by the manufacturers' instruction manuals, was not supplied as original issue but was requisitioned through normal supply channels. Use of this test equipment was well within the capabilities of the field maintenance organization which has maintained the test items in a generally satisfactory manner.

Frequency Meter	TS-174/U
Watt Meter	URN/43/U
Vacuum Tube Voltmeter	TS-375A/U
Multimeter	ME-70/PSM-6
Signal Generator	TS-479B/UR
Cable Assembly	CX-2371/U

- (2) A Motorola Model N-140 Portable Test Set, developed especially for this non-tactical equipment, will eliminate the requirement for all the above referenced test equipment except the CX-2371/U cable assembly. A prototype of the test set was used during the test.

- (3) The following item is not required but is highly desirable for efficient operation of a communications system:

Station Monitor

Motorola Model  
No. F4MU-248( )1C

d. Facilities: Initial installation of a permanent air base communications system requires use of major engineering facilities for surveying, siting, and construction of the steel tower used for the base station antennas. It is anticipated that this type of project would be assigned to the appropriate engineering agency, in conjunction with the base installations activity.

e. Logistics:

- (1) The logistic impact on the using organization, after initial installation, is slight in terms of space, spares, and maintenance facilities.
- (2) A logistic problem will arise in the event it is desired to transfer complete radio sets from one vehicle to another having a different electrical system voltage. In order to operate Radio Sets AN/VRC-19( ) from a different voltage source, it is necessary to change the power supplies for the transmitter and receiver. (Reference paragraphs 1a and 2e and f, Appendix III.)

2. Capabilities and Limitations:

a. Capabilities:

- (1) Radio Sets AN/TRC-28, AN/FRR-36, AN/FRC-27 and the AN/VRC-19 are capable of furnishing reliable communications over line-of-sight ranges when the radio path between stations is unobstructed.
- (2) Radio Set AN/PRC-21(XC-2) is capable of furnishing communication over ranges of approximately one mile.
- (3) Radio Sets AN/TRC-28, AN/FRR-36, AN/FRC-27 and AN/VRC-19 are capable of operation for extended periods with a minimum amount of maintenance.
- (4) The unitized components of the radio sets offer to reduce out-of-service time and simplify maintenance.

- (5) Radio Set AN/VRC-19( ) is capable of operating on 6-, 12- and 24-volt vehicular electrical systems.
- (6) Radio Sets AN/TRC-28 and AN/FRC-27 are capable of being remotely controlled by means of telephone cables and Radio Set Control C-845/U.
- (7) Radio Set AN/FRC-27 is capable of being converted into Radio Set AN/TRC-28 (250 watts output) by the addition of Radio Frequency Amplifier Group OA-442/GR.
- (8) Radio Sets AN/FRC-27, AN/FRR-36, AN/TRC-28, and AN/VRC- are capable of operating in temperatures between -65°F and +165°F and under conditions of high humidity.
- (9) Radio Set AN/PRC-21(XC-2) is capable of operating in the temperature range of -20°F to +165°F and under conditions of high humidity.
- (10) The mobile equipment can be tuned, adjusted and installed in approximately 22 man-hours.
- (11) The fixed equipment, less antenna mast, can be tuned, adjusted and installed in approximately 22 man-hours.

b. Limitations:

- (1) This equipment, operating in the VHF spectrum, is affected by line-of-sight propagation effects. The mobile antenna, being installed at a height of about six feet, is affected by terrain features such as trees, hills and buildings which at times produce dead spots when they intervene between the transmitting and receiving stations.
- (2) The fixed station equipment when operating in relatively level terrain requires an antenna height of approximately 200 feet in order to consistently obtain the 20-mile range outlined in the Military Characteristics. This requirement will change as the surface becomes more hilly and mountainous. Range is dependent upon antenna height above surrounding terrain.
- (3) Both the fixed and mobile equipments are large and heavy; thus, mounting of mobile equipments in some types of vehicles is difficult and space-consuming.
- (4) Radio Receiver R-394/U, used with Radio Sets AN/VRC-19, AN/FRC-27, AN/TRC-28, and AN/FRR-36, is limited to single channel operation by design.

- (5) Radio Set AN/PRC-21(XC-2) is limited to approximately five hours continuous operation at any one time due to short battery life.
- (6) Integrated system operation is hampered because there is no one frequency common to all nets. This requires installation of additional monitor receivers, antennas, intercommunication systems, wires, and cables at the various net control stations, thereby increasing the cost of maintenance and procurement. Under this system dispatchers are required to simultaneously monitor all nets in order to detect any emergency signals.
- (7) Net base stations with a frequency different from the emergency system must act as a relay station between their respective vehicles and the command post during an emergency.
- (8) Net operation is hampered by the lack of "selective calling," "recall" and "leave a message" features.
- (9) Organizations sharing a frequency with another organization must listen to conversations which do not concern them.

3. Tactics and Techniques: No new tactics or techniques were developed with these equipments during the operational suitability test.

4. Collective Analysis:

a. A requirement exists within the Air Force for a communications system to provide efficient and economical communication from a mobile or fixed station of an air base organization to a mobile station of the same unit when radio is employed as a primary means of communication.

b. An additional requirement exists for a communications system to provide adequate service for organizations of an air base during periods of emergency, whereby the function of the units may be controlled, coordinated and directed by one central agency within the air base organizational structure.

c. A requirement also exists for a standard type equipment to replace the various types presently in use.

d. A system composed of the AN/VRC-19, AN/PRC-21, AN/FRR-36, AN/FRC-27, and AN/TRC-28 radio sets does not completely satisfy the above-referenced requirements.

e. The Department of the Army (Signal Corps Engineering Laboratories) states that these equipments were built in accordance with the requirements of U. S. Army Specification MIL-N-11539 (Sig C). This specification calls for a heavy-duty set which is to be used in ground force vehicles where the set can be subjected to immersion in water, dust concentrations, and conditions of shock. As a result, the sets are larger and heavier than sets designed for commercial or non-military use. This imposes an excessive weight and bulk penalty on those USAF air base vehicles which are light commercial types. Their weight and size do not preclude their use for non-tactical military service; however, it does greatly reduce the payload of a vehicle. For example: In a staff car, approximately 50 percent of the useable trunk space is occupied; in a carryall truck with its tail gate up, almost all the available space behind the rear seat is taken up and, with the tail gate down, approximately 50 percent is occupied; in a pickup truck, it is estimated that the radio set takes up approximately one-eighth of the useable cargo space.

f. A comparison of economy of operation of radio-equipped and non-radio-equipped motor pool vehicles indicated no appreciable difference in the cost or economy of operation. The comparison showed that the motor pool in which the test was conducted had a relatively high vehicle utilization rate, which left little room for improvement. It is believed that to achieve any economy it would be necessary to closely limit the operation or use of the vehicles to those functions for which radio control is especially suited. Radio equipment should only be installed in vehicles to be dispatched on numerous trips of short duration and not in vehicles sent to an organization for its exclusive use.

g. It must be pointed out that the equipment tested, as installed in vehicles, costs as much as, and in some cases more than, the vehicle itself, thereby increasing the inventory of a motor pool tremendously. A similar commercial radio set is estimated to cost about one-third as much as the AN/VRC-19( ) radio set.

h. The receivers are designed for single channel operation, and the transmitters were limited to single channel operation by the mandatory use of frequencies authorized in AFR 102-16. These limitations prevented the establishment of a single channel emergency frequency on which all units could operate during emergency periods. During these periods, it was necessary for the command post dispatcher to relay messages to the Fire Protection and Crash Rescue Division, the Motor Vehicle Squadron, the Building and Utilities Division and the railroad vehicles through their respective base stations. The command post and individual net dispatchers could monitor all transmissions on the three frequencies by use of the Radio Receiving Set AN/FRR-36; however, the range of these sets was limited due to the

height of their respective antennas. This method of monitoring the system kept all dispatchers informed of the action being taken during the emergency; however, considerable noise and confusion can exist at the base station while monitoring three frequencies.

i. A local air base regulation requires all vehicles operating on the airdrome to be radio-equipped and capable of communicating with the Control Tower. As a result, the crash rescue, structural fire, field ambulances, and "follow-me" vehicles were placed on one frequency, and the base station was remotely controlled from the Structural Fire Station, Crash/Rescue Station and Control Tower. This action provided control of the vehicles normally operating on the airdrome and kept responsible persons informed of the location and activities of their respective vehicles. However, this system did not provide a means of communication for Air Police, Motor Vehicle Squadron, or Building and Utilities Division vehicles which might have had occasion to be on the airdrome. All operating personnel on this net were required to listen to conversations which did not concern them and was, at times, fatiguing and distracting. This situation was perhaps more noticeable in the Control Tower where personnel were occupied with the direction of aircraft.

j. Installation of the two Radio Receiver Sets AN/FRR-36 at each base station to monitor the other frequencies is not considered an ideal situation because of the interference created (see above). This portion of the system could probably be handled by an intercommunication system. However, such a system would be vulnerable to all difficulties affecting telephone circuits. Because of the shortage of telephone circuits and intercommunications equipment at Eglin Air Force Base this method was not tested.

k. There are several features used in commercial radio systems, such as dual-channel operation and "selective calling," "call back" and "leave a call" features which would, no doubt, increase the capabilities of an air base communications system. As these items were not a part of this system, they were not investigated.

l. The procurement of this equipment is by the Department of the Army. This involves a cross procurement problem through the supply systems of both the Departments of the Air Force and of the Army. The AN/VRC-19 is procured from one manufacturer, the antennas from a different manufacturer, and the crystals from still another source. The assembly of these items at one place is, in itself, an extended supply process. In addition, the system requires the installation of permanent steel transmitting towers embedded in concrete footings. Suitable locations for these installations require a survey of available sites by a competent authority, and installation by an engineering agency on the level of an Air Materiel Area. Thus, it is seen that the adoption of this system throughout the ZI will involve a major engineering



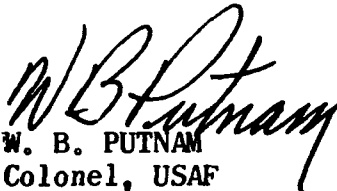
effort to obtain an end product consisting of a simple two-way radio-phone facility in certain air base vehicles. For these reasons, it is felt that consideration should also be given to the feasibility of utilizing off-the-shelf commercial equipments, if such equipments are found to give performance comparable to that of the test items, with resultant savings in size, weight, and cost.

m. The unitized plug-in assemblies offered slight advantage in maintenance during the test period as no spare components were available. However, components from a set known to be in operating condition could be interchanged with those of a non-operating set and the faulty assembly detected. Sufficient test points were available, however, to permit a qualified repairman to locate faulty assemblies without resorting to the replacement method.

n. The two AN/PRC-21 radio sets utilized during this test were the (XC-2) or preproduction models having serial numbers 2 and 3. These sets had been subjected to considerable functional testing prior to arriving at the Air Proving Ground Command for operational suitability testing. The sets were tested with dry batteries only because the wet-cell batteries on hand would not maintain a charge and replacements were not readily available. The battery life of approximately five hours was considered barely satisfactory. The overall performance of the sets was considered satisfactory. The range of communications between AN/PRC-21 radio sets is perhaps rather short, but satisfied the requirements of the Fire Department as to range, portability, and ease of operation.

APPENDICES:

- I - Test Procedure
- II - Test Results
- III - Detailed Description  
of Equipments
- IV - Installations
- V - Equipment Installation  
Times
- VI - Installation Photographs
- VII - Map of Eglin AF Base  
Reservation
- VIII- Ability of Equipment to  
Meet Military Characteristics

  
W. B. PUTNAM  
Colonel, USAF  
Commander

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## TEST PROCEDURE

### 1. Planning:

a. Upon receipt of the test directive, project personnel began a study of the equipment, the existing air base communications system, a proposed plan for a permanent communications system prepared by the Directorate of Communications and Electronics, Air Proving Ground Command, the Civil Defense System for Onondaga County, New York, as described in the July 1951 edition of *ELECTRONICS*, and the system utilized by the Air Research and Development Command in Project R-153-26.

b. Conferences were held with personnel of the various agencies concerned with the test. During these conferences the location, installation, and maintenance of the equipment and the method of conducting the test were discussed, plans were finalized and a test program was prepared.

c. Rome Air Development Center and Mobile Air Materiel Area were queried as to the most suitable towers or masts on which to mount the base station antennas used with this equipment.

d. Discussions were held with civil authorities of the adjacent cities and with personnel of the State Highway Patrol and public utility companies to determine the feasibility of establishing radio circuits with those organizations.

e. Visits were made to other Air Force bases to determine what non-tactical systems were being used and to evaluate the systems.

f. The characteristics of similar commercial equipment in use at Eglin Air Force Base were investigated.

### 2. Installation and Maintenance:

a. Installation (reference Appendix IV) was made under the following procedures: The using organizations drew their allocated number of AN/VRC-19 mobile equipments, an AN/FRC-27, an OA-442/GR amplifier (where authorized), radio crystals, and installation units. These items were then turned over to the Communications Repair Section of the Field Maintenance Squadron for installation. The using organizations submitted work orders to the Installations Wing for the erection of necessary towers, poles, wiring, and structures.

b. The Communications Repair Section unpacked, inspected, installed crystals, tuned, adjusted, and installed the equipment.

c. Installations Wing erected poles and shelters, prepared bases and anchors for towers, and installed power circuits where necessary.

d. Because of the lack of test equipment in the Organizational Maintenance Shop, organizational maintenance was conducted by the Communications Repair Section, Field Maintenance Squadron. Personnel of this organization conducted on-the-job training classes for personnel of the Organizational Maintenance Shop to familiarize them with the equipment. Indoctrination of dispatchers and vehicle operators in the operation of equipment and in radio procedures was also conducted.

e. During the installation period the manufacturers' instruction books, installation drawings prepared by AMC, and a preproduction model of Motorola's Model N-140 Portable Test Set were evaluated.

### 3. Operating Procedures:

a. Each radio net normally operated as an individual net, vehicles being assigned or dispatched on their mission by written or direct orders from organization commanders or dispatchers, changes in orders and/or additional information being sent over the radio circuits.

b. Fire Department Net: The fire department net was used to direct fire equipment and personnel in their assigned tasks both on and off base. In cases of emergencies on the runways, the crash/fire station would receive the alarm and the emergency vehicles would depart for the scene of the emergency, receiving information and directions from the Control Tower operator. Upon arrival at the scene of the emergency, the control of the situation became the prerogative of the fire chief or his representative, who used his vehicular radio or an AN/PRC-21 radio set to direct the use of various vehicles at the scene or to request assistance of additional equipment.

### c. Motor Pool Net:

- (1) It had been planned that the base motor pool would operate a taxi service similar to commercial service. Because of the limited number and variety of radio-equipped vehicles, and because an Air Force bus service is employed at the base, the taxi system was not initiated. The radio-equipped vehicles were indiscriminately placed in operation within the regular vehicle pool. Requests for vehicles were phoned to the motor pool dispatcher who dispatched a vehicle from the motor pool or relayed the request by radio

to a vehicle which might have just completed a trip. Upon completion of a trip the vehicle operator reported by radio that he was free and requested instructions.

- (2) A comparison of economy of operation of radio-equipped and non-radio-equipped motor pool vehicles was conducted. Data were collected on the operation of ten radio-equipped vehicles and, concurrently, on the operation of their counterparts among non-radio-equipped vehicles. Records were kept on total miles operated, broken down into "live" and "dead" miles. "Live" miles were, in reality, "pay-load" miles during which passengers or cargo were actually carried. "Dead" miles were, in effect, miles traveled to pick up such passengers or cargo, and miles traveled, after delivery, either back to the motor pool or to some other place. Similar records were maintained on time of operation and on number of trips per vehicle.

- (3) An investigation was made to determine the cost of certain motor pool vehicles and of the radio equipment installed in them.

d. Building and Utilities Net: The maintenance personnel assigned to the Building and Utilities Division were dispatched to their assigned duties each morning. The communications system was used to reassign or direct these personnel to other jobs, to request additional men or materials and to advise supervisors of progress being made.

e. Air Police Net: The air police net was used to direct air police vehicles in their assigned tasks, which included roving patrols in the adjacent towns of Crestview, Niceville, Valparaiso, and Fort Walton Beach, Florida.

f. Railroad Net: The railroad net was to relay information between the train dispatcher and engineers of the locomotives, both in the yard and en route between Eglin Air Force Base and Mossy Head, Florida. Due to installation delays, the operation of this net was simulated by using radio-equipped vehicles.

g. Control Tower/"Follow-Me" Net: The Control Tower to "follow-me" net was used to direct the "follow-me" vehicles on their assigned tasks on the airfield. This control was exercised over the fire department radio frequency by placing a C-845/U Remote Control Unit in the Control Tower. This arrangement also permitted the Control Tower to communicate with and control the movements of ambulances and crash/rescue vehicles operating on the airfield.

#### 4. Tests Conducted:

a. Range Tests: Tests were conducted on each radio net to determine the satisfactory communications range. Vehicles were dispatched various distances up to 30 miles over various types of terrain (hills, woods, swamps, etc.) during which signal strength and intelligibility were noted.

b. Integrated System Operation: Each net control station and the emergency control center were equipped with three receivers tuned to the three net frequencies, thus allowing each base station operator to monitor all communications over the individual nets. During an emergency the emergency control center was manned and assumed control of the integrated systems. Information and instructions transmitted by the emergency control center were received by all net control stations, and if necessary, were retransmitted to their respective mobile units on their net frequency. Replies from the mobile units were received by their respective net control stations and relayed to the emergency control center.

c. Climatic Tests: The AN/VRC-19, AN/TRC-28, and AN/PRC-21 radio sets were subjected to the following climatic tests. (The AN/FRC-27 and AN/FRR-36 radio sets were not included as they or their components are included in the AN/TRC-28.)

(1) Low Temperature Test: The AN/VRC-19, AN/TRC-28, and AN/PRC-21 were placed in the low temperature chamber to simulate installed conditions, and external control boxes and antennas were connected to the AN/VRC-19 and the AN/TRC-28. A mechanical device was constructed to turn the AN/PRC-21 on and off from outside the test chamber. The temperature was then set at 60°F and maintained at that level for a period of one hour to establish a reference level for the low temperature test. During this period the sets were turned on, operated, and turned off. The temperature was then reduced to 30°F for 7 hours, 0°F for 16 hours, -20°F for 8 hours, -40°F for 16 hours, and -65°F for 24 hours, then abruptly raised to 60°F for 3 hours. After each soak period, the sets were turned on, operated, and turned off. The operational check at 60°F completed the low temperature test.

(2) High Temperature Test: The AN/VRC-19, AN/TRC-28, and AN/PRC-21 were placed in the high temperature chamber to simulate installed conditions, and external control boxes and an antenna were connected to the AN/VRC-19 and the AN/TRC-28. A mechanical device was constructed

to turn the AN/PRC-21 on and off from outside the chamber. The temperature was then set at 60°F and maintained at that level for a period of one hour to establish a reference level for the high temperature test. During this period the sets were turned on, operated and turned off. The temperature was then raised to 100°F for 7 hours, 120°F for 16 hours, 140°F for 8 hours, and 165°F for 24 hours, then lowered as rapidly as possible to 60°F and maintained for a period of 3 hours. After each soak period, the sets were turned on, operated and turned off. The operational check at 60°F completed the high temperature test.

- (3) Humidity Test: The AN/VRC-19, AN/TRC-28, and AN/PRC-21 were placed in the humidity test chamber to simulate installed conditions. External control boxes and an antenna were connected to the AN/VRC-19 and AN/TRC-28. A mechanical device was constructed to turn the AN/PRC-21 on and off from outside the test chamber. The temperature was then set at 81°F with a relative humidity of 95 percent and maintained at that level for a period of one hour to establish a reference level for the humidity test. The temperature was then raised to 90°F with a relative humidity of 100 percent. The temperature of 81°F (95 percent relative humidity) and 90°F (100 percent relative humidity) was alternately changed once each hour for a period of 72 hours. After each temperature and humidity change, the sets were turned on, operated and turned off.

d. Adjacent Channel Interference Tests: A vehicle equipped with an AN/VRC-19 radio set operating on 165.125 megacycles was driven under and adjacent to the antenna of a similar set operating alternately on 165.020 and 165.170 megacycles. While being operated in this manner, communication was maintained with the net base station approximately 1½ miles away on 165.125 megacycles. The vehicle receiver was monitored to determine if any interference was present.

e. AN/PRC-21(XC-2) Radio Set: The AN/PRC-21(XC-2) radio set was utilized in the fire department net. Tests were conducted to determine operating range under various conditions, battery life, and maintenance requirements. Ranges were determined by:

- (1) Communications from inside various buildings and hangars at Eglin Air Force Base (including the Climatic Hangar) to another AN/PRC-21(XC-2) in the same building and to a vehicle parked at various points outside were attempted and quality of service was noted.

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(2) Communications from points inaccessible to a vehicle in the wooded and swampy areas near Eglin Air Force Base were attempted and the quality of service was noted.

5. Records: Records were kept of:

- a. Time required for installation, tuning, maintenance, and repair of all units.
- b. Time required to erect towers, poles, and antennas.
- c. Radio operators' logs.



## TEST RESULTS

### 1. Planning:

a. Authorization for radio frequencies which would allow utilization of the two-channel capability of the transmitter could not be obtained, and it was necessary to revise the test program and operate on the frequencies listed in AFR 102-16.

b. The feasibility of tying in with local civil law enforcement agencies, fire departments, and civil defense organizations was determined to be highly desirable but not feasible due to operating frequencies and equipment incompatibility.

### 2. Installation and Maintenance:

a. All equipments were received in good condition, and preliminary operational checks were satisfactory.

b. Installation time, including tuning, for vehicles, averaged 20.8 man-hours per vehicle, and installation time for the base stations was approximately 22.5 man-hours. (Reference Appendix V.)

c. It was determined that Antenna Mast AB-127 would most nearly meet the requirement for this system. Two of these were installed, one for the air police net and one for the motor pool net. Installation time for this mast was approximately 250 man-hours. (See Appendix VI for illustration of this installation.)

d. Installation of the AN/VRC-19 in various vehicles was not difficult. However, the set takes up considerable load-carrying space when mounted in pickup trucks or staff cars. Radio Set Control C-847/U, because of its size (5-3/4 x 9-1/4 x 3-9/16 inches), is difficult to install in staff cars or similar type commercial vehicles without interfering with the automobile controls or driver comfort. (See Appendix VI.)

e. Some installations of the AN/VRC-19 radio sets on fire-fighting equipment were made before receipt of installation drawings. Radio set locations were locally determined by communications, fire-fighting, and project personnel. When installation drawings were received, a study revealed that in many instances the equipments could not be located in the designated places because the space was occupied by fire-fighting equipment.

f. Location of AN/VRC-19 radio set on the roof of the tactical ambulance, as specified by the drawings supplied, was considered unsatisfactory by communications, medical, and project personnel because it

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could easily be damaged in heavily wooded areas when used on a crash-rescue mission. It was decided to mount the radio set on the floor in the front of the litter compartment.

g. Installation and maintenance were performed effectively by a Senior Ground Radio Repairman (AFSC 30450) assisted by three Ground Radio Mechanics (AFSC 30430).

h. Both mobile and fixed station operators required approximately three hours of indoctrination in the operation of the equipment and in the operating procedures contained in ACP-125A Communications Instructions, Radio Telephone Procedures.

i. Instruction manuals supplied with the equipment were found adequate for installation, operation, and maintenance.

j. The test equipment (required but not supplied) used during testing proved adequate for tuning and maintenance. (Reference paragraph 1c.) It was found that three patch cords (Special Purpose Electrical Cable Assembly CS-2371/U) are necessary when performing bench maintenance on this equipment. The Motorola Model N-140 Portable Test Set eliminated the requirement for all the test equipment listed except for the station monitor, Motorola Model No. F4MU-24B( )1-C.

k. It was determined that a definite periodic inspection schedule should be established, during which a qualified radio repairman can inspect each set, note its performance, and realign it if necessary. This inspection should be conducted approximately every seven to ten days. A station monitor, Motorola Model No. F4MU-24B( )1-C, will aid maintenance personnel in these inspections and will help to detect those sets or station transmitters which are dropping off in efficiency.

### 3. Operation:

#### a. General:

- (1) The terrain where the tests were conducted consists of low sand hills with a thick growth of scrub or low woods. Range and intelligibility checks between the base stations and various vehicles revealed that two-way line-of-sight communication could be maintained over approximately 18 - 20 miles, depending on base station antenna height, with excellent intelligibility. "Talk-out" and "talk-back" communications ranges were approximately the same. Vehicle-to-vehicle communications ranges were approximately six miles. However, there were instances of dead spots where communication could not be maintained. These were encountered when the

mobile units were shielded by intervening terrain or foliage. Communication with these radio sets is accomplished in the band of 152 to 174 megacycles. Radio waves at these frequencies tend to travel in straight lines. For this reason, line-of-sight transmission paths are of major importance as signal strength attenuates rapidly over paths which have obstructions between the transmitter and receiver. Although the radio waves bend slightly around obstructions, reliable communication occurs only when line-of-sight paths exist. Line-of-sight transmission is attained when the transmitter antenna is approximately within optical range of the receiver antenna. The most important factors limiting the line-of-sight distance are the curvature of the earth and intervening hills.

- (2) Investigation conducted on characteristics of the equipment revealed the following:
- (a) The equipment was found to have good frequency stability; however, the transmitter, when keyed for a period of more than one minute, would drift slightly. This drift can be noted by a slight change in discriminator voltage, but is within limits.
  - (b) The receivers were checked aurally against a TS-174 frequency meter, and good selectivity was noted.
  - (c) The equipments were found to have sufficient test points for maintenance and alignment.
  - (d) It was found that "plug-in" assemblies were readily changeable and aided to some extent in trouble shooting. However, tubes were often "glued-in" by solder-rosin or the lacquer used for fungus proofing, and were broken before they could be removed.
  - (e) All components and subassemblies are readily accessible for maintenance.
  - (f) The equipment required little repair, and running spares supplied were adequate.
  - (g) The controls were well marked and easily operated.
  - (h) In general, the audio output was clear and intelligible; however, in the fringe areas or where the radio path was obstructed by buildings or trees, even though at close ranges, the speech became garbled and background noise increased.

- (i) Checks on the receiver revealed that it is not affected by adjacent channel interference.
  - (j) It was found that the earphone of Handset H-33/PT was unnecessary, and that the speaker, part of Radio Set Control C-847/U, had excellent intelligibility and volume. Further, most vehicle operators did not use the earphone but depended entirely upon the control unit speaker.
  - (k) The AN/TRC-28 for the fire department was found to operate satisfactorily from a local control position and two remote sites over telephone cable, with a minimum of interference from cross-talk on telephone systems.
  - (l) It was found that this equipment generally meets the requirements of Military Characteristics No. 329, dated 17 February 1955. (Reference Appendix VIII.)
- (3) AN/TRC-28: The AN/TRC-28 radio set is essentially an AN/FRC-27 radio set with a Radio Frequency Amplifier Group OA-442/GR added. The addition of the amplifier did not improve the range or intelligibility over that provided by the basic AN/FRC-27, under conditions of this test; however, specialized requirements such as overriding control may warrant the use of this equipment.
- (4) AN/PRC-21: Operation of the AN/PRC-21(XC-2) radio set was generally satisfactory.
- (a) Communications between an AN/PRC-21(XC-2) and an AN/VRC-19 or an AN/FRC-27 could be maintained to approximately one mile in range.
  - (b) Communications between AN/PRC-21(XC-2) radio sets could be maintained over approximately three-tenths of a mile in range.
  - (c) Communications from inside various buildings to a vehicle outside could be maintained in all cases except in certain remote locations in the Climatic Hangar.
  - (d) Dry batteries gave an operating life of approximately five hours.
  - (e) Wet batteries were unsatisfactory in that the batteries on hand would not maintain a charge and new ones were not available.

b. Motor Pool Net:

- (1) Operation of the motor pool net was satisfactory, and it was determined that vehicles could be effectively controlled and dispatched by radio.
- (2) A comparison of economy of operation of radio-equipped and non-radio-equipped motor pool vehicles revealed no significant difference in efficiency of operation between vehicles with or without radios. "Live" or "payload" miles in each case were almost exactly two-thirds of total miles traveled. "Live" time was also very similar, being 84.5 percent and 87.6 percent, respectively. Radio-equipped vehicles made more and shorter trips, averaging 3.3 miles per trip as compared to 7.2 miles for vehicles without radios.
- (3) It was determined from Air Force Stock Catalogs that the cost of the radio-equipped vehicles utilized in the test is as follows:

<u>Type Vehicle</u>	<u>Cost of Vehicle</u>	<u>Cost of Radio Set and Installation</u>	<u>Total Cost</u>
Staff Car			
1951 Chevrolet	\$1345.11	\$1400.00	\$2745.11
Pickup			
1951 Chevrolet	1187.00	1400.00	2587.00
1951 Ford	1238.11	1400.00	2638.11
Carryall			
1951 Chevrolet	1625.00	1400.00	3025.00

c. Fire Department Net:

- (1) Operation of the fire department net was satisfactory. It was found that the use of the radio aided greatly in the control of fire and crash/rescue vehicles on both "on-base" and "off-base" missions.
- (2) Initial communications range checks on the fire department vehicles revealed reliable ranges of eight to ten miles. Maintenance personnel reported the sets were difficult to tune and would only load up to five watts power output. A check of the antenna system revealed that the vehicular antenna was resonant to a frequency of approximately 163 megacycles. The antenna was shortened so that it was resonant at approximately 174

megacycles. The sets then tuned much easier and loaded to approximately 19 watts output. The communications range was increased to 15 - 18 miles. (See Appendix VII.)

d. Air Police Net: Operation of the air police net was satisfactory. It was possible to maintain effective communications with roving patrols in the adjacent towns of Crestview (21 miles), Niceville (4 miles), Valparaiso (3 miles), and Fort Walton Beach (9 miles), Florida. (See Appendix VII.)

e. Building and Utilities Division Net:

(1) The operation of the building and utilities division net was satisfactory. It was found that the vehicles of this net could be effectively controlled over the "line-of-sight" communication range afforded by the base station antenna height. (See Appendix VII.)

(2) It was found that the use of radio aided materially in the efficient operation of the Building and Utilities Division.

f. Control Tower/"Follow-Me" Net: Operation of the Control Tower/"Follow-Me" net was satisfactory. Effective communications could be maintained between the Control Tower and "Follow-Me" vehicles. In addition, the Control Tower was able to control the movements of crash/rescue and "follow-me" vehicles on the airfield.

g. Integrated Systems Operation: Tests revealed that the individual net control stations could intercommunicate and that an emergency control center could assume control of the individual nets when they were operated as an integrated system. However, it was very fatiguing and distracting to the station operators as they had to listen to traffic on the other nets in addition to their own.

4. Climatic Tests:

a. AN/VRC-19 Radio Set: Radio Set AN/VRC-19 operated satisfactorily at temperatures between -65°F and +165°F and under humidity conditions of 95 and 100 percent relative humidity.

b. AN/TRC-28 Radio Set: Radio Set AN/TRC-28 operated satisfactorily at temperatures between -65°F and +165°F and under humidity conditions of 95 and 100 percent relative humidity.

c. AN/PRC-21 Radio Set: Radio Set AN/PRC-21 (XC-2) operated satisfactorily at temperatures between +165°F and -20°F and under humidity conditions of 95 and 100 percent relative humidity. At temperatures below -20°F, the batteries failed to operate. When the temperature was raised above -20°F, operation was satisfactory.

## DETAILED DESCRIPTION OF EQUIPMENTS

1. Description: The equipments utilized in the communications system are crystal-controlled, frequency-modulated units operating in the VHF band between 152-174 megacycles. The equipments consist of the AN/VRC-19, AN/FRC-27, AN/TRC-28 radio sets, the AN/PRC-21 portable radio set and the AN/FRR-36 radio receiving set. These items are described as follows:

a. AN/VRC-19: Radio Set AN/VRC-19 is a mobile set with a power output of approximately 25 watts on one of two preset frequencies. The radio set can be installed in several different types of vehicles, such as railroad trains, jeeps, sedans, trucks, and ambulances. The cabinet which houses the radio set can be mounted in various positions to facilitate installation. Flexibility for use in vehicles with differing voltage systems is provided by the use of plug-in power supplies. It is only necessary to insert the correct power supplies for the receiver and transmitter and make a few simple interconnections when shifting the set from one vehicle to another. The radio set consists of Electrical Equipment Cabinet CY-936/VRC, Radio Receiver R-394/U, a receiver power supply, Radio Transmitter T-278/U, a transmitter power supply, Radio Set Control C-847/U, an antenna, and associated cabling. The equipment cabinet comes with a mounting cradle, which allows the cabinet to be mounted either horizontally or vertically, with the following dimensions: horizontally - 11¼ inches high, 23½ inches wide, and 17½ inches deep; vertically - 18¼ inches high, 23½ inches wide, and 11¼ inches deep. The set weighs approximately 108 pounds.

b. AN/FRC-27: Radio Set AN/FRC-27 is a fixed-station set with a power output of approximately 45 watts. It consists of a Radio Receiver R-394/U, Radio Transmitter T-416/GR, Power Supplies PP-346/U and PP-804/U, Radio Set Controls C-844/U and C-845/U, Electrical Cabinet CY-1221/G, Base Stand MT-1176/FR, and the antenna system. The dimensions of the AN/FRC-27 when set up for operation are 44-¾ inches high, 21-¾ inches wide, and 17 inches deep. The complete set weighs 297 pounds. Various combinations of associated components permit using Radio Set AN/FRC-27 in a number of different ways. Manipulation of one switch will enable the radio set to operate on either of two preset frequencies. This operation is accomplished either locally or at a

remote site up to 10 miles away. Operation of the radio set is primarily push-to-talk (simplex). However, duplex operation can be effected by the use of two frequencies so that transmission and reception can occur simultaneously. In addition to operation between two points of communication, the radio set can be used as an automatic relay (retransmission) station between two points too widely spaced for direct communication.

c. AN/TRC-28: Radio Set AN/TRC-28 is intended for fixed-station use with a power output of approximately 250 watts or with a reduced power output of approximately 50 watts. The AN/TRC-28 radio set is essentially an AN/FRC-27 radio set with a Radio Frequency Amplifier Group OA-442/GR added. The amplifier weighs approximately 185 pounds, and measures 26½ inches high, 20¼ inches wide, and 16.2 inches deep.

d. AN/FRR-36: Radio Receiving Set AN/FRR-36 is a fixed-station receiver designed for single channel reception only. It consists of Radio Receiver R-394/U mounted in Electrical Equipment Cabinet CY-1150/U. The power source required is 115 or 230 volts at 50 or 60 cycles. The controls and a speaker are on the front panel of the cabinet. The antenna is a vertical quarter-wave type.

e. AN/PRC-21: Radio Set AN/PRC-21 is a lightweight pack set operating on a single crystal-controlled channel. Operating power may be supplied from either dry batteries or from a wet-cell vibrator unit. The power-supply compartment is hermetically sealed from the radio compartment. A mounting bracket for railway use is supplied for either vertical or horizontal mounting surfaces. Provision is made for connection of an external antenna.



## 2. Technical Characteristics of Components:

### a. Radio Transmitter T-278/GR:

Frequency range:	152 to 174 mcs.
Transmitter type:	Crystal-controlled frequency-modulated.
Distance range:	Line-of-sight.
Type of modulation:	Frequency-modulated, as derived from phase modulation.
Frequency deviation:	15 kcs deviation for 100 percent modulation at 1000 cycles. Deviation limited to 15 kcs for all frequencies.
Type of transmission:	Voice.
Crystals:	
Type:	JAN CR-27/U, calibrated for 32 micro-microfarad circuit.
Frequency range:	4750 to 5437.5 kcs.
Multiplication factor in transmitter:	32 times on all frequencies.
Output impedance:	50 ohms into coaxial cable.
Audio input:	
Carbon microphone:	100 mv for 100 percent modulation at 1000 cycles.
600-ohm line input:	200 mv for 100 percent modulation at 1000 cycles.
Spurious emission:	Attenuated at least 70 db below carrier.
Number of tubes:	13
Antenna:	1/4 wavelength vertical.
Power supply:	External DC operated Dynamotor-Power Supply DY-100/U, Dynamotor DY-93/U, or Dynamotor-Power Supply DY-98/G.
Power output:	Dynamotor-Power Supply DY-98/G, 30 watts.
Weight, unmounted:	8-3/4 pounds.

**b. Radio Transmitter T-416/GR:**

Frequency range:	152 to 174 mcs.
Transmitter type:	Crystal-controlled frequency-modulated.
Distance range:	Line-of-sight.
Type of modulation:	Frequency-modulated, as derived from phase modulation.
Frequency deviation:	15 kcs deviation for 100 percent modulation at 1000 cycles. Deviation limited to 15 kcs for all frequencies.
Type of transmission:	Voice.
Crystals:	
Type:	Crystal Unit CR-27/U, calibrated for 32 micro-microfarad circuit.
Frequency range:	4750 to 5437.5 kcs.
Multiplication factor in transmitter:	32 on all frequencies.
Preset frequency operation:	Maximum of 500 kcs between two frequencies.
Output impedance:	50 ohms into coaxial cable.
Audio input:	
Carbon microphone:	100 mv for 100 percent modulation at 1000 cycles.
600 ohm line input:	200 mv for 100 percent modulation at 1000 cycles.
Spurious emission:	Attenuated at least 70 db below carrier.
Antenna:	Nominal 1/4 wavelength, folded, vertical.
Number of tubes:	12.
Power supply:	AC operated Power Supply PP-804/U.
Power output:	50 watts.
Weight, unmounted:	80-3/4 pounds.

c. Radio Frequency Amplifier AM-494/GR:

Frequency range:	152 to 174 mcs (continuous).
Number of tubes:	2.
Input excitation:	Radio Transmitter T-416/GR with its tune-operate switch in the tune position.
Power output:	250 watts.
Coupling impedance:	
Input:	50 ohms.
Output:	50 ohms.
Power supply:	External AC operated Power Supply PP-638/U.
Type of antenna used:	1/4 wavelength folded vertical radiator.
Weight:	13 pounds.

d. Radio Receiver R-394/U:

Frequency range:	152 to 174 mcs.
Receiver type:	Double conversion, crystal-controlled, superheterodyne, fixed frequency.
Crystal range (third overtone):	24,033 to 27,700 mcs.
Type of signals which can be received:	Frequency-modulated (15 kcs deviation).
Number of tubes:	22.
Intermediate frequencies:	7.8 mcs and 455 kcs.
Output impedance:	8 ohms.
Power output:	15 watts at less than 10 percent distortion.
Audio frequency response:	300 to 3500 cps $\pm 1$ db (without de-emphasis). 6 db per octave $\pm 1$ db (with de-emphasis).
Special features:	Squelch and muting circuits.
Power supply:	115 or 230 volts, 50 to 65 cps AC Power Supply PP-846/U.
Antenna:	1/4 wavelength folded vertical radiator.
Weight:	18 pounds.

e. Dynamotor Power Supplies DY-100/U, DY-98/U, and DY-93/U:

Power input:

Dynamotor Power Supply 6 volts DC. 40 amperes.

DY-100/U:

Dynamotor DY-93/U: 12 volts DC. 20 amperes.

Dynamotor Power Supply

DY-98/G:

24 volts DC. 10 amperes.

Power output:

380 volts DC: 180 milliamperes.

225 volts DC: 70 milliamperes (available at pin 9 for Radio Transmitter T-278/U).

225 volts DC: 45 milliamperes (available at pin 3 for Radio Transmitter T-208/U).

-25 volts DC: 5 milliamperes.

24 volts DC: 1.2 milliamperes (Dynamotor Power Supply DY-98/G).

6.3 volts DC: 2 amperes (Dynamotor Power Supply DY-98/G).

6 volts DC: 3 amperes.

6 volts DC: .9 amperes (Dynamotor Power Supply DY-100/U and Dynamotor DY-93/U).

6 volts DC: 2 amperes (Dynamotor Power Supply DY-100/U and Dynamotor DY-93/U).

1.3 volts DC: 2 amperes.

1.3 volts DC: 1 ampere.

Adaptability to service conditions:

Altitude: 10,000 feet maximum.

Shocks and vibrations: Will withstand shocks, strains, and vibrations in a vehicle traveling over rugged terrain.

Weather and climate: Fungi-proofed and moisture-proofed.

Normal operating temperature: -40°C (-40°F) to +65°C (149°F).

Weight: 24 pounds.

Dimensions: 14-1/2 inches long, by 7 inches wide, by 8-5/8 inches high.

f. Receiver Power Supplies PP-867/U, PP-868/U and PP-869/U:

Rated input power:

PP-869/U:	6 volts DC.	3.7 amperes.
PP-868/U:	12 volts DC.	2.0 amperes.
PP-867/U:	24 volts DC.	1.1 amperes.

Filament and heater circuit power drains:

PP-869/U:	6.3 volts DC.	.45 ampere.
	6.3 volts DC.	1 ampere.
	1.4 volts DC.	1.25 amperes.

PP-868/U:	6.3 volts AC.	.45 ampere.
	6.3 volts AC.	1 ampere.
	1.4 volts AC.	1.25 amperes.

PP-867/U:	6.3 volts AC.	.45 ampere.
	24 volts DC.	250 milliamperes.
	1.4 volts DC.	1.25 amperes.

Plate, screen, and bias circuit power drains:

155 volts DC.	15 milliamperes.
150 volts DC.	5 milliamperes.
140 volts DC.	50 milliamperes.
-40 volts DC.	.5 milliampere.

Adaptability to service conditions:

Altitude:	10,000 feet
Shock and vibration:	Will withstand shocks, strains, and vibrations in a vehicle operating over rugged terrain.
Weather and climate:	Fungi-proofed and moisture-proofed.
Normal operating temperature:	From $-40^{\circ}\text{C}$ ( $-40^{\circ}\text{F}$ ) to $+70^{\circ}\text{C}$ ( $+158^{\circ}\text{F}$ ).
Dimensions:	5 inches high by 6-1/4 inches wide by 7 inches long.
Weight:	10 pounds.

g. Power Supply PP-846/U:

Power input:

115 volts,	46 volt-amperes,	50 to 65 cps AC.
230 volts,	46 volt-amperes,	50 to 65 cps AC.

Filament and heater circuit power drains:

6.3-volt heaters, .45 ampere.  
6.3-volt crystal heater, .9 ampere.  
1.4-volt filament, 1.25 amperes.

Plate, screen grid, and bias circuit power drains:

160 volts DC, 15 milliamperes.  
155 volts DC, 5 milliamperes.  
145 volts DC, 50 milliamperes.  
-40 volts DC, .5 milliampere.

Ambient temperature: From  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) to  $+70^{\circ}\text{C}$   
( $+158^{\circ}\text{F}$ ).

Weight: 10 pounds.

h. Power Supply PP-804/U:

Power input:

115 volts, 230 volt-amperes, 50 to 65 cps AC.  
230 volts, 230 volt-amperes, 50 to 65 cps AC.

Power output available for Radio Transmitter T-416/GR:

500 volts DC, 250 milliamperes.  
225 volts DC, 70 milliamperes.  
1.35 volts DC, 1.0 ampere.  
1.3 volts DC, .2 ampere.  
-25 volts, DC, 5 milliamperes.  
6 volts DC, .3 ampere.  
6 volts AC, .9 ampere.  
6 volts AC, 2.1 amperes.

Ambient temperature: From  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) to  $+65^{\circ}\text{C}$   
( $+149^{\circ}\text{F}$ ).

Weight: 40 pounds.

i. Power Supply PP-638/U:

Power output:

Plate supply: 1100 volts DC at 340 milliamperes.  
Screen grid supply: 225 volts DC at 40 milliamperes.  
Filament supply: 6 volts AC at 5.2 amperes.

Power input: 660 watts at 115 or 230 volts,  
60 cps AC.

Number of tubes: 3.

Weight: 173 pounds.

j. Radio Set Control C-844/U:

Number of relays:	3.
Audio attenuation:	0 to 30 db.
Audio input impedance:	600 ohms.
Audio output impedance:	600 ohms.
Weight:	10 pounds.

k. Radio Set Control C-845/U:

Number of tubes:	3.
Type of signals used:	Audio frequency.
Audio frequency power output at speaker:	.5 watt at less than 10 percent distortion.
Audio frequency voltage output:	-2 dbm across 600 ohm line.
Audio frequency response:	±2 db 300 - 3500 cps.
Power supply:	Power Supply PP-846/U, 115 - 230 volts, 60 cps AC.
Weight:	17-1/2 pounds.

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## INSTALLATIONS

### Installations Made, Equipment Installed, and Frequency Used

#### 1. Command Post:

1 Radio Set AN/FRC-27	163.475 mcs
1 Radio Receiving Set AN/FRR-36	173.575 mcs
1 Radio Receiving Set AN/FRR-36	165.125 mcs
3 Antennas. AT-438/GR antennas mounted on 30-foot poles with an approximate height above sea level of 100 feet.	

#### 2. Air Police Net:

1 Radio Set AN/FRC-27	163.475 mcs
1 Radio Frequency Amplifier Group OA-442/GR	
1 Radio Receiving Set AN/FRR-36	173.575 mcs
1 Radio Receiving Set AN/FRR-36	165.125 mcs
16 Trucks Carry-all AN/VRC-19y	
3 Antennas. One AT-438/GR antenna for the AN/FRC-27 located on 180-foot tower. Antenna height above sea level approximately 200 feet. Monitor receiving antennas mounted on roof of building.	

#### 3. Crash/Fire Net:

1 Radio Set AN/FRC-27	Structural Fire Station 173.575 mcs
1 Radio Receiving Set AN/FRR-36	163.475 mcs
1 Radio Receiving Set AN/FRR-36	165.125 mcs
1 Radio Frequency Amplifier Group OA-442/GR Structural Fire Station	
1 Radio Speaker	
1 Desk Microphone	
1 Remote Control Unit C-845/U	Crash Fire Station
1 Remote Control Unit C-845/U	Control Tower
4 ea O-10 Truck, Fire, Crash/Rescue	AN/VRC-19
9 ea O-11A Truck, Fire, Crash/Rescue	AN/VRC-19
1 ea Truck, Pickup	AN/VRC-19
3 ea Truck, Pickup	AN/VRC-19y
3 ea Truck, Class 500 Pumper	AN/VRC-19
1 ea Truck, Class 750 Pumper	AN/VRC-19X
1 ea Truck, Water Distributor	AN/VRC-19
1 ea Truck, Emergency Rescue, Type R-2	AN/VRC-19

4 ea Field Ambulances	AN/VRC-19
3 ea Truck, Pickup, "Follow-Me" vehicles	AN/VRC-19y
3 ea Antenna. AN/FRC-27 antenna located on 80-foot pole with antenna approximately 150 feet above sea level. Monitor receiving antennas mounted on roof of fire station.	

4. Motor Pool and Building and Utilities Division Nets:

1 ea Radio Set AN/FRC-27	Motor Pool	165.125 mcs
1 ea Radio Receiving Set AN/FRR-36	Motor Pool	173.575 mcs
1 ea Radio Receiving Set AN/FRR-36	Motor Pool	163.475 mcs
1 ea Radio Set AN/FRC-27	Bldg & Utils. Div.	165.125 mcs
1 ea Radio Receiving Set AN/FRR-36	Bldg & Utils. Div.	173.575 mcs
1 ea Radio Receiving Set AN/FRR-36	Bldg & Utils. Div.	163.475
2 ea Truck, Carry-all	Motor Pool	AN/VRC-19y
6 ea Truck, Pickup	Motor Pool	AN/VRC-19y
2 ea Staff Car,	Motor Pool	AN/VRC-19y
10 ea Trucks	Bldg & Utils. Div.	AN/VRC-19y
3 ea Antenna, Motor Pool, AN/FRC-27 antenna located on 180-foot tower with antenna approximately 200 feet above sea level. Monitor receiving antennas located on roof of motor pool building.		
3 ea Antenna. Building and Utilities Division, AN/FRC-27 antenna located on 70-foot pole approximately 80 feet above sea level. Monitor receiving antennas located on roof of building.		

## EQUIPMENT INSTALLATION TIMES

### 1. Vehicles:

<u>TYPE VEHICLES</u>	<u>MAN-HOURS PER INSTALLATION</u>
O-10 Truck, Fire, Crash/Rescue	17
O-11A Truck, Fire, Crash/Rescue	6-1/2
Truck, Structural Fire Class 500 Pumper	37
Truck, Structural Fire Class 750 Pumper	24
Truck, Water Distributor	20
Truck, Pickup	28
Truck, Carry-all	29
Staff Car	21
Truck, 1-1/2 ton cargo	20
Field Ambulance	12

### 2. Base Stations:

AN/FRC-27 Radio Set	22-1/2
OA-442/GR Radio Frequency Amplifier Group	10

### 3. Antenna Masts:

AB-127	250
90-foot poles	10

INSTALLATION PHOTOGRAPHS

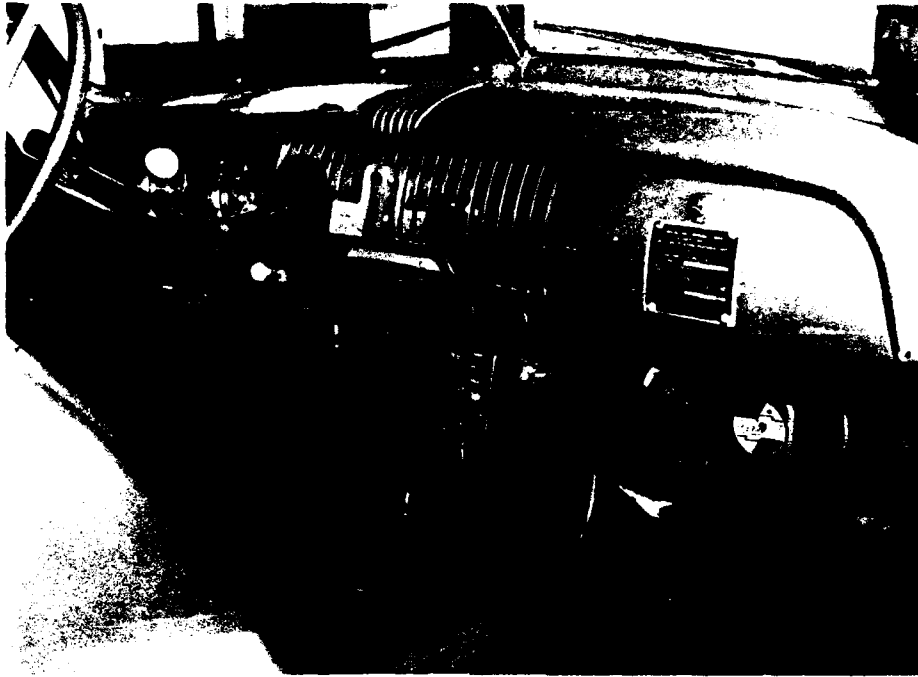


FIGURE 1  
AN/VRC-19 Control Box Mounted in Commercial Type Vehicle



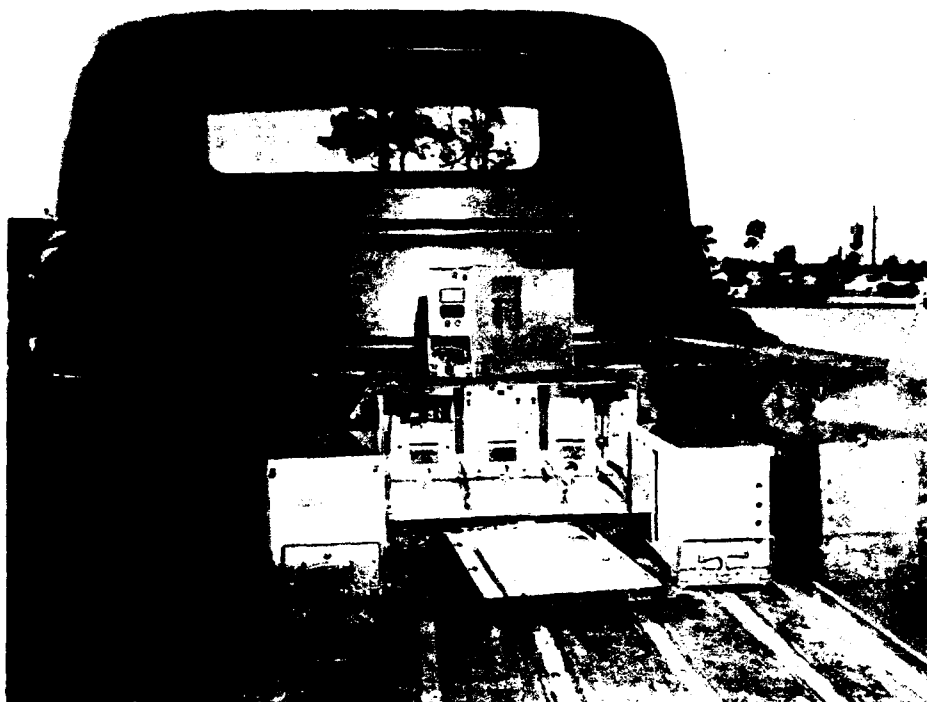
FIGURE 2  
AN/VRC-19 Mounted in Staff Car



FIGURE 3  
AN/VRC-19 Mounted in Carry-All Truck



FIGURE 4  
AN/VRC-19 Mounted in Field Ambulance  
Appendix VI, Page 2



**FIGURE 5**  
**AN/VRC-19 Mounted in Pickup Truck**  
**(AN/VRC-19 Components Removed from Case)**



**FIGURE 6**  
**AN/VRC-19 Mounted on Class 500 and O-11 Fire Trucks**



FIGURE 7  
AB-127 Antenna Mast

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## ABILITY OF EQUIPMENT TO MEET MILITARY CHARACTERISTICS

### 1. OBJECTIVE:

a. A primary operational need exists for a system to provide an economical and efficient mobile radio communications system for a function within the air base operational structure. Equipment furnishes an efficient mobile communications system.

b. A secondary operational need exists for a system to provide economical communications and coordinated control of all vehicles during periods of emergency whereby mobile and static elements of a military installation could be controlled, coordinated and directed by one command element. Meets requirements with the exception of the economical aspect, which was not investigated and the fact that control of all vehicles cannot be obtained from one command element, except by relay through another fixed station.

### 2. PROPOSED SERVICE EMPLOYMENT:

a. This communications system will be utilized within air bases. Capable of being used within air bases.

b. The mobile components of this system will be installed in standard military and commercial type vehicles. The fixed components will be installed in suitable shelters. Portable components will be handcarried by personnel. Meets requirements.

c. The components of this system will not be a new development but the utilization of these components to provide a system to meet the requirements of this military characteristic is a new development. Components are a development by the Signal Corps, US Army. The utilization of these equipments in this system is new to the Air Force.

### 3. FUNCTIONAL REQUIREMENTS:

a. The primary function of this system is to provide communications between mobile elements and fixed element and between mobile elements and other mobile elements of base activities when adequate communications for the activities cannot be obtained by other methods. Meets requirements.

b. The secondary function of this system is to provide an efficient method of coordinating the movement of mobile non-tactical elements of a military installation by one command element of the installation during periods of stress or emergency. Meets specifications with the exception that all vehicles cannot be directly controlled by one command element. Control must be exercised through the base station of each individual net.

### 4. OPERATIONAL CHARACTERISTICS:

a. Frequency coverage: Meets requirements. \*  
Limits 150-175 mcs.

b. Channel requirements Limited to three channels by Hq  
shall be held to an absolute minimum for efficient system operation. USAF and by AFR 102-16.

c. Phase modulation. Meets requirements. \*

d. Voice. Meets requirements. \*

e. Range of Transmission/ Reception. The range of transmission/reception shall be a minimum of twenty (20) miles omni-directional from each transmitting station. Suitable relays shall be used where the topography prevents coverage of the above range. Capable of twenty (20) mile omni-directional range depending on height of antenna and terrain.

f. Spatial Coverage: Meets requirements. \*  
Radiation of the antennas shall be

omni-directional except where the employment of directive radiators will improve coverage and minimize interference with near or adjacent military installations on the same operating frequency.

g. Interference Elimination: Equipment employed shall be so designed to permit adjacent channel operation.

Meets requirements. \*

h. Stability: The frequency stability of this system shall be commensurate with the limits prescribed by existing F.C.C. regulations.

Meets requirements. \*

i. Accuracy or Fidelity: The required fidelity shall be adequate for the transmission of voice frequencies.

Meets requirements. \*

j. Special Features: All major items of receiving and transmitting equipment shall be capable of being integrated into a common system. A minimum of radio frequencies shall be employed necessary for efficient and reliable communications. A single basic transmitter and receiver (fixed); basic mobile transceiver; and basic portable transceiver covering the frequency range of 150-175 mcs shall be employed.

Meets specifications.

## 5. PHYSICAL CHARACTERISTICS:

a. Limiting Weight and Volume Factors: The mobile and portable equipment shall be capable of being installed in standard military, commercial, and special purpose vehicles; fire and crash vehicles; and locomotives.

Meets requirements. However, it occupies most of the space in the trunk of staff cars and presented installation problems in field ambulances. Is considerably larger and heavier than similar commercial items.

**b. Arrangement and Co-ordination of Component Units:**

- |   |                     |
|---|---------------------|
| (1) The fixed transmitters and receivers shall be controlled from dispatcher's positions or position. Suitable means of intercommunicating between dispatcher's positions shall be provided when the fixed facilities are remotely controlled from two or more locations. | Meets requirements. |
| (2) The mobile transceiver shall be remotely controlled from the driver's seat and installed in such a manner as to permit ease of maintenance.   | Meets requirements. |

c. Provisions for Equipment to Operate in Conjunction with other Electronic and Intended Associated Equipment: Provisions shall be made for future expansion, the integration of this radio system and the base telephone system, and suitable equipment provided for direct radio communications to search aircraft.	Not investigated.
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d. Anticipated Power  
Supply Considerations:

- |   |                     |
|---|---------------------|
| (1) The fixed station equipment shall operate from the normal 115/230 volt 50-60 cycle commercial power mains. The mobile installations shall operate from the battery of the vehicles. The portable units shall be battery operated. | Meets requirements. |
| (2) Emergency power with an automatic transfer unit shall be employed at fixed stations only.   | Not investigated.   |

e. Adaptability to Alteration: Interchangeable components shall be employed throughout this system.	Meets requirements.
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f. Equipment Arrangement:

- |   |                     |
|---|---------------------|
| (1) Controls other than the operator's microphone, receiver volume control, on-off switch and transmitter frequency change switch shall not be located near the operator. | Meets requirements. |
| (2) Loudspeakers shall be located near the operator.  | Meets requirements. |

6. EQUIPMENT OPERATION AND MAINTENANCE CHARACTERISTICS:

a. Operating Time: The receiver of the mobile transceiver shall be capable of continuous operation and the transmitter of this transceiver shall be capable of a duty cycle of one to five. The receiver, remote control units and transmitters of the fixed station shall be capable of continuous operation. Meets requirements.

b. Permissible Scope of Continuous and Periodic Adjustments, Tuning, Calibrating, Maintenance, etc: All components of this system shall be designed so that maintenance will be kept to a minimum. Meets requirements.

c. Control Features Not Consistent With Or Included in Standard Systems, Including Associated Communications Circuits and Special Links: Provisions for special links shall be provided for radio communications to nearby civilian law-enforcing agencies and fire protection agencies. Not investigated.

d. Maximum Acceptable Preparation Periods from Secured or Power Off Conditions:

(1) The maximum acceptable preparation period of the components of this system to standby conditions shall be 45 seconds. Meets requirements.

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- |  |                     |
|--|---------------------|
| (2) Full operation of the components of this system shall be instantaneous from the standby condition. | Meets requirements. |
|--|---------------------|

e. Personnel Considerations:

- |   |                     |
|---|---------------------|
| (1) Special skills or training required for the maintenance personnel shall be that required of a radio maintenance mechanic. | Meets requirements. |
| (2) Operators shall not require any special training other than a lecture on net discipline and procedure.                    | Meets requirements. |

f. Provisions for Field Maintenance: Special tools and test equipment shall not exceed that which is authorized a radio maintenance mechanic.	Does not meet requirements. Requires special test equipment.
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g. Special Features: All tuning adjustments shall be placed in a location on the components in such a manner that unauthorized personnel could not maintain or tune the component.	Meets requirements.
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\* These items were investigated by the Signal Corps Engineering Laboratory. In a letter to the Air Force Operational Test Center, dated \_\_\_\_\_ SCEL states that these test items meet the intent of military specifications MIL-N-11539 - (SigC).